
الجامعة الأردنية
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Introduction

- Dietary nutrition supplies ***carbohydrates, lipids, and proteins*** that drive cellular metabolism.
- The chemical processes that maintain cellular viability consist of ***catabolic (breakdown)*** and ***anabolic (synthesis)*** reactions.

Introduction

- Feeding drives synthesis and storage, whereas starvation promotes the mobilization of energy.
- In preparation to fight or flight, physiologic stressors also mobilize energy stores.
- Populations stressed by surgery are at a unique metabolic disadvantage since they are often nutritionally restricted perioperatively

NUTRIENT METABOLISM

- CARBOHYDRATES
  - The primary energy source for the body, providing ***30% to 40%*** of calories in a typical diet.
  - ***Brain and red blood cells*** rely almost exclusively on a steady supply of glucose to function.
  - Each gram of ***enteral carbohydrate*** provides ***4 kcal of energy***, whereas ***parenteral*** formulations are hydrated and thus provide only ***3.4 kcal/g***.

CARBOHYDRATES

- **Glucose Stores**
  - During fed states, hyperglycemia leads to insulin secretion, promoting glycogen synthesis.
  - About 12 hours worth of glycogen is available in the liver and skeletal muscles, which can provide a steady supply of glucose between meals.
  - During starvation and stress, depleted glycogen stores cause the release of glucagon, which promotes hepatic gluconeogenesis from amino acids.

- If dietary carbohydrates are not resumed, glucagon promotes ketone body formation from lipids, which the brain can utilize. (later stage of starvation)

- A minimum intake of 400 calories of carbohydrate per day minimizes protein breakdown. (glucose saline)

CARBOHYDRATES

- **Carbohydrate digestion**
  - Initiated by the action of salivary amylase, and absorption is generally completed within the first 1 to 1.5 m of small intestine.

NUTRIENT METABOLISM

- **LIPIDS.**
  - Fatty acids are the functional units of lipid metabolism.
  - They comprise ***25% to 45%*** of calories in the typical diet.
  - During starvation, lipids provide the majority of energy in the form of ketone bodies converted by the liver from long chain fatty acids.
  - ***Each gram of lipid provides 9 kcal of energy.*** double amount produced by carbs or proteins

LIPIDS

- Lipid Storage.
  - Lipids are important energy sources for the heart, liver, and skeletal muscle.
  - Free fatty acids are bound to a glycerol backbone and join to form triglyceride during fed states.
  - Triglycerides are stored in adipocytes and can be mobilized in times of stress or starvation.
  - Lipolysis is stimulated by ***steroids, catecholamines, and glucagon***, whereas ***insulin*** promotes synthesis and storage.

LIPIDS

- Digestion and absorption of lipids
  - complex and utilizes nearly the entire GI tract.
  - Coordination between biliary and pancreatic secretions.
  - functional jejunum and ileum are necessary.

→ that's why patients with short bowel syndrome suffer from malabsorption

PROTEIN

- Amino acids are the functional units of protein metabolism.
- Proteins are important for the biosynthesis of enzymes, structural molecules, and immunoglobulins.
- When energy needs are unmet by nutrition, muscle breakdown yields amino acids for hepatic gluconeogenesis, which can lead to wasting.
- ***Each gram of protein can be converted into 4 kcal of energy.***

PROTEIN

- Digestion of proteins yields dipeptides and single amino acids, which are actively absorbed.
  - Once digested, almost 50% of protein absorption occurs in the duodenum, and complete protein absorption is achieved by the mid jejunum.
- Metabolism of absorbed amino acids occurs initially in the liver where portions of amino acids are extracted to form circulating proteins.

both proteins and carbs are absorbed completely at the mid jejunum most unlike lipids that are absorbed along the whole small bowel

STRESS METABOLISM

- Alterations in metabolism
  - physiologic stress share similar patterns with simple starvation.

- Regardless of the stimulus, our conserved response to stress is the same and catabolic shifts mobilize energy stores in order to prepare us for the fight or flight.

STRESS METABOLISM

- The interaction of metabolic and endocrine responses that result from major operation, trauma, or sepsis can be divided into three phases.

- **Catabolic Phase.** After major injury, the metabolic demand is dramatically increased, as reflected in a significant rise in the urinary excretion of nitrogen
  - Following a major surgical procedure, protein depletion inevitably occurs because patients are commonly prevented from eating in addition to having an elevated basal metabolic rate.
  - The hormonal response of physiologic stress includes
    - Elevation in the serum levels of glucagon, glucocorticoids, and catecholamines.
    - Reduction in insulin.

STRESS METABOLISM

- **The early anabolic phase** (corticoid withdrawal phase)
  - ***several days to several weeks***.
  - ***can last from a few weeks to a few months,*** depending on many factors, including the ability of the patient to obtain and use nutrients and the extent to which protein stores have been depleted.
  - This phase is marked by a positive nitrogen balance, and there is ***a rapid and progressive gain in weight and muscular strength.***

STRESS METABOLISM

- **The late anabolic phase** is the final period of recovery and may last from several weeks to months.
  - Adipose stores are replenished gradually and nitrogen balance equilibrates.
  - Weight gain is much slower during this period than in the early anabolic phase due to the higher caloric content of fat and the primary energy stores deposited during the early anabolic phase

NUTRITIONAL ASSESSMENT

- Nutrition plays a vital and often underappreciated role in the recovery of patients from surgery. It is estimated that between 30% and 50% of hospitalized patients are malnourished.

- While most healthy patients can tolerate 7 days of starvation, patients affected by major trauma, surgery, sepsis, or other critical illnesses require nutritional intervention earlier.
- Poor nutrition has deleterious effects on wound healing and immune function,
  - increases postoperative morbidity and mortality.

CLINICAL ASSESSMENT

- ***History:***

- Specific inquiries pertinent to nutritional status include recent history of weight fluctuation with attention as to the timing and intent.
  - Recent weight loss (***5% in the last month or 10% over 6 months***)
  - Current body weight of ***80% to 85%*** (or less) of ideal body weight suggests severe malnutrition.
  - ***Energy intake ≤50%*** of estimated energy requirement for ≥5 days also indicates severe malnutrition.

→ for males: height - 100 ± 10

* for females: height - 110 ± 10

- Anorexia, nausea, vomiting, dysphagia, odynophagia, gastroesophageal reflux, or a history of generalized muscle weakness should prompt further evaluation.

- A complete history of current medications is essential to alert caretakers to potential underlying deficiencies as well as drug and nutrient interactions.

- **Physical examination**
  - Muscle wasting (especially thenar and temporal muscles),
  - Loose or flabby skin (loss of subcutaneous fat).
  - Peripheral edema and/or ascites (hypoproteinemia).
  - Subtler findings of nutritional deficiency include
    - skin rash, pallor, glossitis, gingival lesions, hair changes, hepatomegaly, neuropathy, and dementia.

tanular somathi's

- **Laboratory tests**
  - Are nonspecific indicators of the degree of illness rather than strict markers of nutrition.
  - ***Albumin, prealbumin, and transferrin*** vary with nutritional status, as well as with the body's response to inflammation:
    - levels should be interpreted with caution.
  - Other laboratory indicators of inflammation include C-reactive protein (CRP), white blood cell count, and blood glucose levels.

TYPES OF MALNUTRITION

- **Overnutrition.**
  - Obesity as defined by body mass index (BMI) >30.

- **Undernutrition**
  - Caloric ***(Marasmus)***
  - characterized by inadequate protein and caloric intake, typically caused by illness-induced anorexia.
  - It is a chronic nutritional deficiency marked by losses in weight, body fat, and skeletal muscle mass.
  - Visceral protein stores remain normal, as do most laboratory indices.

Noncaloric *(Kwashiorkor)*

- characterized by catabolic protein loss, resulting in hypoalbuminemia and generalized edema. This form of malnutrition develops with prolonged starvation or severe stress.
- Even in a well-nourished patient, a severe stress (e.g., major burn or prolonged sepsis) may rapidly lead to depletion of visceral protein stores and impairment in immune function.

kwashiorkor

swelling of legs (oedema)

sparse hair

moon face, with little interest in surroundings

flaky appearance of skin

swollen abdomen

thin muscles, but fat present

ascites and edema
because of impaired protein metabolism

marasmus

normal hair

old man or wizened appearance

thin limbs with little muscle or fat

very underweight body

general

ESTIMATION OF ENERGY NEEDS

- Indirect calorimetry remains the gold standard in measuring energy expenditure in the clinical setting.
  - It measures ***CO2 production and O2 consumption*** during rest and exercise at steady-state to calculate total energy expenditure (TEE).

ESTIMATION OF ENERGY NEEDS

during night, no stress, trauma or infection

- Basal energy expenditure (BEE) can be predicted by using the **Harris-Benedict equation** (in kilocalories per day):
- For men equals
  - 66 + [13.7 × weight (kg)] + [5 × height (cm)] – [6.8 × age (years)].
- For women equals
  - 655 + [9.6 × weight (kg)] + [1.8 × height (cm)] – [4.7 × age (years)].
- Healthy subjects vs. critically ill patients and those at the extremes in weight.
  - BEE must be adjusted for activity and injury level

Respiratory quotient (RQ)

- Represents the ratio of expired CO2 to O2 consumed.

- This ratio can provide valuable information regarding the primary energy substrate being utilized.
  - ***RQ of 1*** indicates glucose oxidation
  - ***0.8*** indicates protein utilization,
  - ***0.7*** indicates fat metabolism.

NUTRITION ADMINISTRATION

- Surgical patients present a unique set of challenges to clinicians who must determine when, how, and what to feed them.
- Safe administration of an oral diet requires that the patient should have an intact chewing/swallowing mechanism along with a functioning alimentary tract.
- The timing, route, and type of nutrition are important considerations in surgical patients.

INITIAL TIMING OF ADMINISTRATION

- Open abdominal surgery produces a paralytic ileus of variable length that alters the digestion and absorption of nutrients.

- Resolution, marked by the passage of flatus, occurs in most patients within 72 hours of surgery and is symptomatic of functional GI continuity.
  - Return of bowel function begins with the small intestine within hours of surgery, is followed by the stomach at 48 hours, and finally by the colon, typically at 72 hours.

ROUTE OF ADMINISTRATION

- Oral administration of nutrition is the preferred route since it is the most physiologic and the least invasive.

- In patients with a functioning GI tract, several requirements must still be met, before initiating an oral diet.
  - Mental Alertness and Orientation.
  - Intact Chewing/Swallowing Mechanism..

DIET SELECTION

- **Transitional diets** minimize digestive stimulation and colonic residue while providing more calories than IV fluids alone in patients recovering from postoperative ileus.

- Advancement to the next stage should be predicated on frequent assessment of the patient's bowel function in the absence of nausea, vomiting, or distention.

- **Clear liquids**
  - provide fluids mostly in the form of sugar and water.
  - short-term use after an acute illness or surgery when there is an intolerance for foods, and to prepare the bowel for surgery or a GI procedure.
  - This diet provides between 700 and 1,000 kcal per day.
  - Examples include carbonated beverages, clear gelatin, fruit ices and popsicles, most juices, coffee, tea, and clear broth.

- **Full liquids**
  - include foods that are liquid at body temperature, such as gels and frozen liquids.
  - Transition to full liquids is good for patients who have undergone head and neck surgery and thus may have some difficulty swallowing postoperatively.
  - Full liquids provide approximately 1,200 kcal and 40 g of protein per day.

- **Regular diet**
  - represents an unrestricted regimen that includes various foods designed to meet all caloric, protein, and elemental needs.

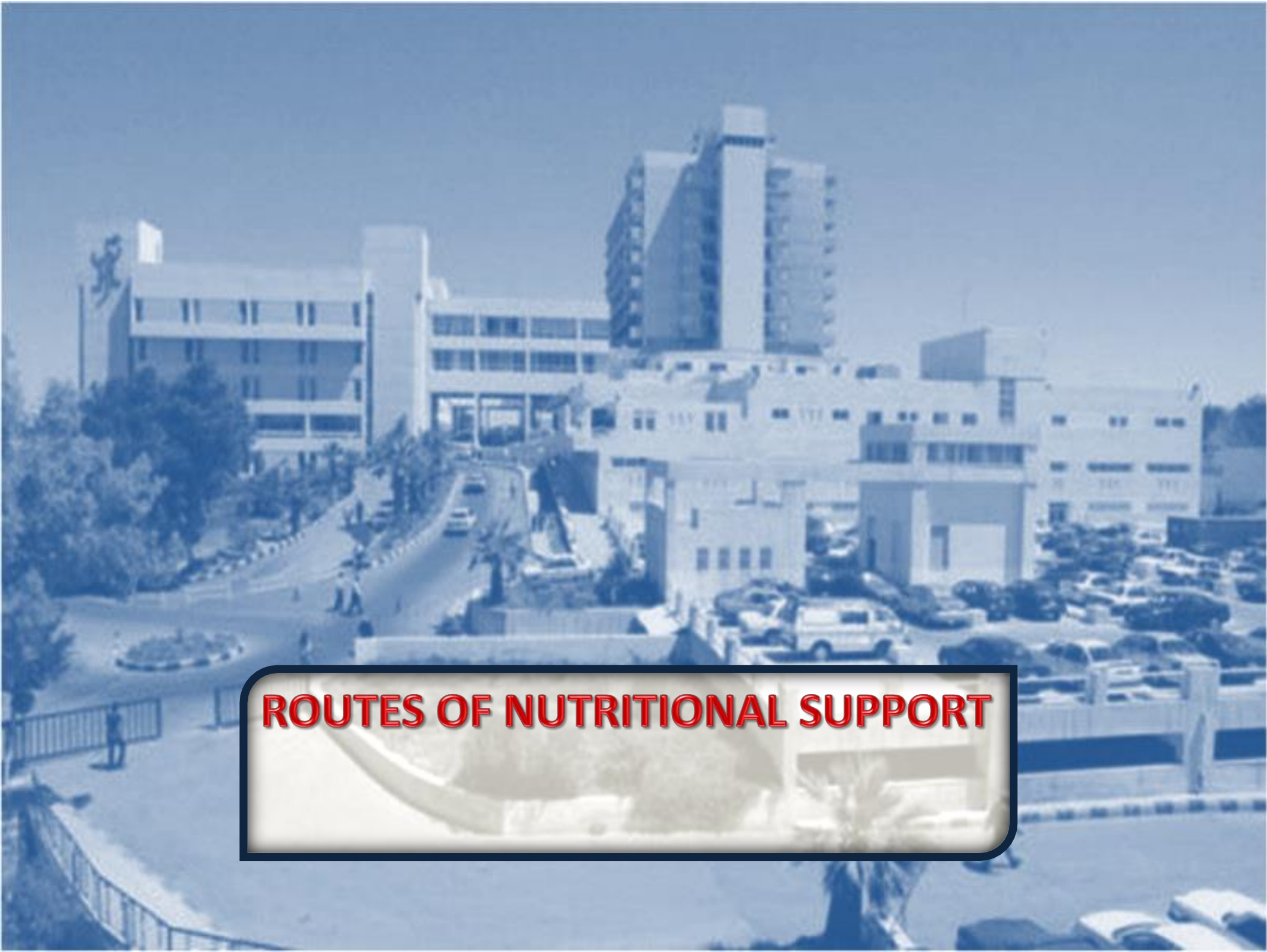
NUTRITIONAL SUPPORT

- The need for nutritional support should be assessed continually in patients both preoperatively and postoperatively. Most elective surgical patients have adequate fuel reserves to withstand common catabolic stresses and partial starvation for up to 7 days and do not benefit from perioperative nutritional support

  » (Nutrition. 2000;16:723Ñ 728).

- For these patients, IV fluids with appropriate electrolytes and a minimum of 100 g glucose daily (to minimize protein catabolism) is adequate.

- Without nutritional intervention, these patients may suffer complications related to impaired immune function and poor wound healing from depleted visceral protein stores.


ROUTES OF NUTRITIONAL SUPPORT

ROUTES OF NUTRITIONAL SUPPORT

- **Enteral:** (most preferable)
  - Simple, physiologic, and relatively inexpensive.
  - Enteral feeding maintains the GI tract cytoarchitecture and mucosal integrity (via trophic effects), absorptive function, and normal microbial flora.
  - This results in less bacterial translocation and endotoxin release from the intestinal lumen into the bloodstream.

- Enteral feeding is indicated for patients who have a functional GI tract but are unable to sustain an adequate oral diet,

- Contraindicated in patients with an
  - intestinal obstruction, upper GI bleeding, severe diarrhea, intractable vomiting, enterocolitis, a high-output enterocutaneous fistula, and severe IBD..

- **Feeding tubes.**
  - Nasogastric, nasoduodenal or jejunal, gastrostomy, and jejunostomy tubes are available for the administration of enteral feeds.

- **Enteral feeding products.**
  - Various enteral formulas are commercially available. Standard solutions provide 1 to 2 kcal/mL.
  - The available dietary formulations for enteral feedings can be classified as standard, elemental, or semi-elemental.

- **Enteral feeding protocols.**
  - It is recommended to start with a full strength formula at a slow rate, which is steadily advanced.
  - This reduces the risk of microbial contamination and achieves goal intake earlier.
  - Conservative initiation and advancement are recommended for patients who are critically ill, those who have not been fed for some time, and those receiving a high osmolarity or calorie-dense formula.

- **Conversion to oral feeding.**
  - When supplementation is no longer needed, an oral diet is resumed gradually.
  - In an effort to stimulate appetite, enteral feeding can be modified by the following measures:
    - **Providing fewer feedings.**
    - **Holding daytime feedings.**
    - **Decreasing the volume of feedings.**
  - When oral intake provides approximately 60% of the patient's energy requirements and 100% of the patient's fluid requirements, the physician should consider discontinuing tube feeding.

Complications

- **Metabolic derangements.**
  - Abnormalities in serum electrolytes, calcium, magnesium, and phosphorus can be minimized through vigilant monitoring.
  - Hypernatremia may lead to the development of mental lethargy or obtundation.
  - Hyperglycemia may occur in patients receiving tube feeds and is particularly common in ***preexisting diabetics*** or in the ***setting of sepsis***.

- **Refeeding syndrome**
  - a potentially lethal complication in patients who are severely malnourished. Alterations in phosphate, potassium, magnesium, and thiamine can be seen which can lead to harmful effects on the cardiac, respiratory, hepatic, neuromuscular, and hematologic systems

» (Eur J Clin Nutr. 2008;62:687-694).

- **Clogging** can usually be prevented by careful routine flushing of the feeding tube.

- **Tracheobronchial aspiration** of tube feeds
  - may occur with patients who are fed into the stomach or proximal small intestine and can lead to major morbidity.
  - Precautions include frequent assessment of gastric residuals as well as head of bed elevation.

- **High gastric residuals**
  - As a result of outlet obstruction, dysmotility, intestinal ileus, or bowel obstruction may limit the usefulness of nasogastric or gastrostomy feeding tubes.
  - Treatment of this problem should be directed at the underlying cause.
  - If gastric retention prevents the administration of sufficient calories and intestinal ileus or obstruction can be excluded, a nasojejunal or jejunostomy feeding tube may be necessary.

- **Diarrhea**
  - occurs in 10% to 20% of patients;
  - Diarrhea may result from an overly rapid increase in the volume of hyperosmolar tube feedings, medications, or substances (e.g., lactulose or sorbitol).
  - If other causes of diarrhea can be excluded, the volume or concentration of tube feedings should be decreased.
  - Antidiarrheal agents such as loperamide should be reserved for patients with severe diarrhea who have had infectious etiologies excluded.

Parenteral nutrition

→ feeding through veins and it could be central or peripheral

- Indicated for patients who require nutritional support but cannot meet their needs through oral intake and for whom enteral feeding is contraindicated or not tolerated,
  - extensive small bowel resection, perforated small bowel, high output enterocutaneous fistula, severe emesis or diarrhea, bowel obstruction.

PN — Partial → PPN → peripheral
PN — Total → TPN → all nutrition requirements delivered through the vein

- **Peripheral parenteral nutrition (PPN)**
  - administered through a peripheral IV catheter.
  - The osmolarity of PPN solutions generally is limited to **900 mOsm** to avoid phlebitis.
  - Temporary nutritional supplementation with PPN may be useful in selected patients but is not typically indicated.

Total parenteral nutrition (TPN)

- provides complete nutritional support. The solution, volume of administration, and additives are individualized on the basis of an assessment of the nutritional requirements.

- **Access.**
  - Central venous catheter, ***CVP***
  - Subclavian or internal jugular vein.

} because of high fluids osmolarity

(Same fluids centrally and peripherally → thrombophlebitis)

- **TPN solutions**

  are generally administered as a three-in-one admixture of

  - Protein, as amino acids (10%, 4 kcal/g);
  - Carbohydrate, as dextrose (70%, 3.4 kcal/g);
  - Fat, as a lipid emulsion of soybean, safflower, or olive oil (9 kcal/g).

- **Additives.**
  - **Electrolytes** (sodium, potassium, chloride, acetate, calcium, magnesium, phosphate)
  - **Medications** such as H2-receptor antagonists and insulin can be administered in TPN solutions.
  - **Vitamins and trace elements**
    - added daily using a commercially prepared mixture that includes copper, chromium, selenium, manganese, and zinc.

Administration of TPN

- most commonly a continuous infusion. A new three-in-one admixture bag of TPN is administered daily at a constant infusion rate over 24 hours..

- **Cyclic administration of TPN**

Administered for 8 to 16 hours, most commonly at night. This should not be done until metabolic stability has been demonstrated for patients on standard, continuous TPN infusions.

- **Discontinuation of TPN**
  - should take place when the patient can consistently satisfy 60% of their caloric and protein needs with oral intake or enteral feeding and 100% of the daily fluid needs.

- **Complications Associated with TPN**

- **Catheter-related complications**
  - can be minimized by strict aseptic technique and routine catheter care.

- **Metabolic complications**
  - include electrolyte abnormalities and glucose homeostasis.
  - While it was previously thought that strict maintenance of serum glucose levels below 110 mg/dL improves mortality, it was shown in the NICE-SUGAR study that intensive glucose control actually increased mortality. ***Therefore blood glucose levels should be kept below 180 mg/dL***
    - » (N Engl J Med. 2009;360:1283-1297).

Go loose not tight

- **Cholestasis**
  - Common metabolic complication of long-term parenteral nutrition. This is due to the lack of enteral stimulation for gallbladder contraction. Cholestatic liver disease may ultimately lead to biliary cirrhosis, which is treated with transplantation.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